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Use of Geosynthetics in Municipal Solid Waste Disposal Facilities

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16. ABSTRACT

The use of geosynthetics is increasing in all types of waste management facilities. The use of flexible membranes for containment and geonets and geotextiles for conveyance of liquids and gases will allow the design community to develop innovative designs. However, the use of geosynthetics is not without technical issues. This paper will discuss the issues of chemical resistance and biological/particlaute clogging of these materials.

Chemical resistance evaluation of all geosynthetics is required for hazardous waste containment. Method 9090 is the recognized method to expose the material and specific tests have been recommended to assess the rate of change in selected physical properties. The use of this technique in MSW facilities may or may not be required. Several issues including the proposed method will be discussed and recommendations made.

Biological/particulate clogging of synthetic drainage materials has been under investigation for over two years. Initial results indicate that MSW leachate will support a good biological mass that will in fact clog the geosynthetics. Results also indicate that the biologicals do not degrade the geosynthetics. Control techniques such as a surface biocide or a migrating biocide are being evaluated. These results will be discussed. Particulate clogging is also a design feature that requires consideration when designing MSW disposal facilities. This latest design information will also be discussed.

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The Use of Geosynthetics in Municipal Solid Waste Disposal Facilities

The use of geosynthetics is increasing in all types of waste management facilities. Their use has been brought about by their ability to outperform soils as barrier, drainage, and filter media; by consistency of material properties over the entire facility; their adaptability to innovative designs; ease of construction; and low cost. Their relative newness in waste management applications, i.e. only 10-20 years field experience, has led to certain technical issues that require additional discussions and perhaps additional research. Two issues receiving recent attention will be briefly discussed in this paper: (1) chemical resistance of the materials and (2) the biological/particulate clogging potential of geosynthetics used in leachate collection systems. For more detail the reader should consult the cited references.

CHEMICAL RESISTANCE

Chemical resistance of geosynthetic materials is essential if they are to perform over the active and post-closure periods of the facility and even beyond. Geosynthetics are being used extensively in hazardous waste management applications. One criterion for approval of geosynthetic use in hazardous waste is passage of EPA Method 9090 chemical compatibility test (1,2). Method 9090 requires that samples of the geosynthetic be evaluated after immersion for periods of 30, 60, 90 and 120 days in the leachate from the waste management facility. Leachate temperatures should be 20°C and 50°C. The immersion vessel should not be made of the same material as the geosynthetic being tested and should not compete with the geosynthetic for potentially aggressive leachate constituents. The vessel should be sealed with no free air space in order to prevent the loss of volatile constituents from the leachate.

An alternative immersion procedure is being developed by ASTM D-35 Committee on Geosynthetics. This ASTM procedure closely follows the procedure of Method 9090 but adds details regarding test conditions and the immersion vessel. This ASTM procedure is under review by the U.S. EPA for acceptance in lieu of portions of Method 9090.

The materials used in constructing municipal solid waste (MSW) disposal facilities must be resistant to generated leachate. However, several technical issues need to be addressed including representative leachate, potentially aggressive constituents in the leachate, and the test method itself.

Representative Leachate

The intent of requiring a representative leachate in a chemical resistance test is to assure that the geosynthetic is exposed to all

potentially aggressive constituents that could affect its long-term performance. The leachate samples may be taken from the sump areas for existing landfills. The concern with this approach is whether these samples represent the worst case. It is well known that leachate aggressiveness toward FMLs is the strongest (represents the worst case) early in the life of a landfill (3). Over the life of the landfill the contaminants will be washed out of the landfill and the leachate quality will improve. If the "representative" sample of leachate is removed for compatibility testing from the landfill late in its life there is a good chance that it will not represent the worst case. On the other hand, if the "representative" sample of leachate is removed early in the life of the landfill, it may be several years before the geosynthetics tested for compatibility are actually installed. Due to the rapid improvements in geosynthetic quality there is a good chance that the geosynthetic tested will not be of the same composition as the material to be installed. The latter problem faces many owner/operators. The Agency has taken the position that the "fingerprint" or chemical makeup of the geosynthetic evaluated for chemical resistance should be essentially the same as the material installed (2).

Since we generally know (3) what the chemical make-up of the leachate is, why don't we make a synthetic leachate? Ham (4) investigated the development of a synthetic MSW leachate. Difficulties were encountered, such as the changing of the leachate quality with time, the development of a proper carrier medium for the synthetic leachate, and the impact of the biological constituents. It was apparent that more questions were raised than answered. Therefore, synthetic leachates have not been recommended, because they cannot completely and accurately represent the fluids that geosynthetics may encounter in service.

Potentially Aggressive Constituents

A review of the literature (3) to determine the chemicals found in municipal solid waste leachate suggests that almost any chemical or combination might be found. Haxo (5) performed a study to determine if solubility parameters of geosynthetics could be used for determining chemical resistance. This study evaluated 28 polymeric compositions against 30 organics and deionized water. The 28 polymers included basic polymers and compound variations, such as type, level of crystallinity, crosslink density, filler, and amount and type of plasticizers. The 30 organics covered a wide range of Hildebrand solubility parameters as well as the component solubility parameters, i.e. dispersive polarity and hydrogen-bonding components. The conclusions indicate that this technique may have value for chemical resistance evaluations.

Haxo (6) has more recently reviewed the issue of aggressive agents in MSW leachate. His study indicates that recent reported analyses of leachates show the presence of priority pollutants, aromatic hydrocarbons, and other constituents which may be absorbed by geosynthetics. He further

states that, in view of the distribution coefficients, or ratios of chemical concentrations between aqueous solution and a geosynthetic, the absorption of a given organic from an aqueous solution would be less at low concentrations compared with that at higher concentrations. Because concentrations are ordinarily very low in MSW leachates, the absorption of organics by geosynthetics may be so low that it will not significantly affect the properties of the geosynthetics. Also, as the landfill ages, the leachate will probably become less concentrated, so that there will not be any further increase in absorbed organics in the geosynthetic, and lower amounts of organics in the geosynthetic will be at equilibrium with the leachate. This also suggests that small-generator waste may not influence the amount of organics ultimately absorbed by the geosynthetic.

Test Method 9090

Haxo (6) also assessed the feasibility of performing EPA Method 9090 using MSW leachates. The study expectedly found that MSW leachate is a highly complex mixture of inorganics, organics and bacteriological constituents usually generated in anaerobic environments. The leachate has a high oxidation potential and is unstable and subject to rapid changes in quality upon removal from the environment in which it was generated. Even sealing in refrigerated bottles will not prevent the changes.

Method 9090 requires that the testing be performed at room and elevated temperatures and that samples be removed at selected time intervals for analysis. Due to the instability of MSW leachate, these requirements do not readily lend themselves to conducting chemical resistance testing of geosynthetics by this method. If not this method then what procedure, if any, should be used? Again, a review of the literature may point us in the right direction.

In the late 70's and early 80's the U.S. EPA conducted laboratory experiments to determine the chemical resistance of polymeric membranes and other materials to MSW leachate (7). These exposure tests involved placing liner samples in landfill simulators containing 8 feet of compacted, shredded urban refuse, and in immersion tanks containing MSW leachate and water. A third test involved placing leachate inside a bag made of the liner material and then placing that bag inside a polybutylene bag containing deionized water. Materials tested included 4 admixed materials, 2 asphaltic membranes, 50 commercial polymeric membranes, and 9 miscellaneous materials. Exposing the wide range of polymeric membranes to a typical MSW leachate in the landfill simulators for up to 56 months produced only limited changes in material properties. It should be noted that the composition of the membranes was similar to that of the geosynthetic products used in today's applications. With some reservations (e.g., the simulators represented one batch loading of waste rather than continuous addition of new wastes), the tests indicated that geosynthetics would withstand exposure to MSW leachate.

We can conclude from the above discussion on chemical resistance that:

- chemical resistance of geosynthetics in waste management applications is an appropriate issue for concern;
- the presently designed EPA Method 9090 should probably not be used for assessing the compatibility of geosynthetics with MSW leachate unless the concentrations of the aggressive organics, e.g. the aromatics and chlorinated hydrocarbons in the leachate appear sufficiently high to pose problems; and
- commercially available geosynthetics are probably appropriate for use in MSW waste management facilities where industrial waste disposal is relatively small.

BIOLOGICAL/PARTICULATE CLOGGING

Surveys and studies have been performed to identify the potential for clogging of leachate collection systems (8,9). Although these surveys did not excavate leachate drainage systems, there was some evidence that clogging would be a concern, especially in municipal solid waste (MSW) leachate collection systems. It is well known that the leachate from MSW landfills has a high biological component (3). The fine particles in MSW also can intrude into those collection systems and reduce their ability to perform as they were designed.

A study of geosynthetics was undertaken to evaluate the potential for clogging, determine if the clogging was biological or particulate, determine whether biological clogging was detrimental to the geosynthetic, and to develop appropriate controls to mitigate clogging (10).

The first phase of the study evaluated both aerobic and anaerobic conditions at six landfills over a twelve-month time frame (11). Ten geotextiles were used for this initial work. The aerobic phase results indicated that:

- flow was reduced 40% to 100%
- geotextile opening size played a key role, with larger sizes allowing for the passage of clogging sediment and/or dormant biologicals;
- the type of geosynthetic polymer is of no significance;
- soil clogging could not be separated from geosynthetic clogging; and
- particulate clogging could not be distinguished from biological clogging.

The anaerobic incubated samples indicated:

- smaller flow reductions, 10% to 40%;
- that biological build-up was cumulative as confirmed by

photo-micrographs which showed progressively greater biological accumulation over the 12-month evaluation period;
- there was no physical attachment to the geosynthetics; and
- there was no strength loss of the geosynthetics over the 12-month period.

The second phase, which is underway now, was redesigned to provide additional answers not obtained in the first phase. The objectives of phase II are:

- to compare and distinguish the sand filter clogging from the geotextile filter clogging;
- to distinguish the particulate clogging from the biological clogging;
- to distinguish aerobic clogging from anaerobic clogging.

The testing apparatus was designed to:

- operate with continuous or periodic flow;
- operate under variable head or constant head conditions;
- be backflushed with leachate and results assessed; and
- be backflushed from either side with biocide and the results assessed.

The initial results of the second phase indicate:

- a stabilization of the flow under continuous flow conditions, suggesting that the near-term filtration characteristics of the soil/geotextile perform as designed;
- aerobic and anaerobic clogging is similar;
- flow changes are more distinguishable when geotextiles are not covered with sand; and
- long-term clogging still occurs (69 of 96 test columns had $\geq$ 50% clogging).

Initial leachate backflushing experiments were encouraging; a 51% flow rate increase for the sand/geotextile combination and 63% for the geotextile alone. The study is expected to be completed in September 1991. It is anticipated that recommendations on designs and corrective additions for leachate collecting systems will be part of the final report.

SUMMARY

Two concerns that face the Agency in the use of geosynthetics in municipal solid waste land disposal facilities have been discussed. Chemical resistance of membranes has traditionally been evaluated, for hazardous waste, by Method 9090. This method may be unsuitable for chemical resistance evaluation when using MSW leachate, unless there appears to be a high concentration of organics (aeromatics and/or

chlorinated hydrocarbons). Long-term studies conducted by the Agency suggest that commercially available geosynthetics may be used for urban refuse land disposal facilities without deterioration by exposure to the leachate.

Biological/particulate clogging of geosynthetic drainage materials continues to be researched. Preliminary results indicate biological clogging does not degrade the geosynthetic and that backflushing may be a partial corrective action for clogged systems.

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